Bridging the Gap: A Novel 2M/LIHC Hybrid Indicator

Understanding Energy Poverty Indicators

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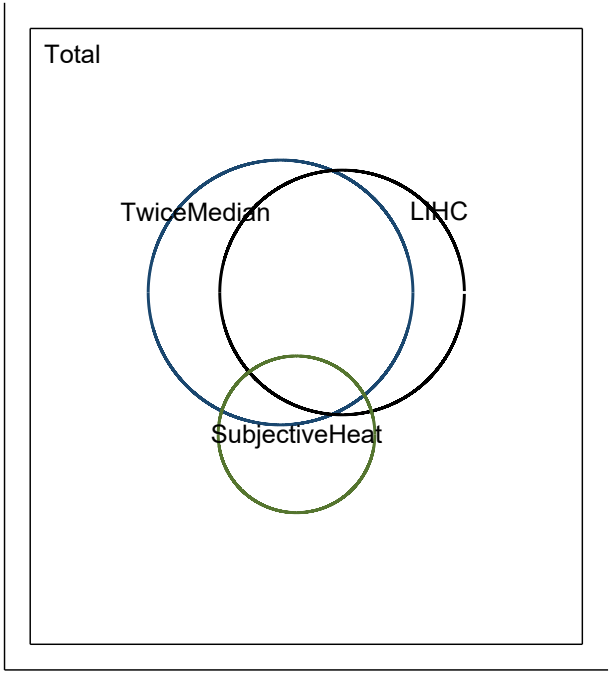
Kaleidoscopic Nature of Energy Poverty

- Different indicators identify different populations as energy poor [Menyhért, 2024]
- Less than 1/3 of energy poor suffer from multiple forms [Menyhért, 2024]
- Existing frequently used indicators present conflicting pictures of energy poverty's prevalence and distribution ex post vs ex ante [Deller et al., 2021].



Note: TwiceMedian (A): 16.19%, LIHC(B): 13.82%, SubjectiveHeat(C): 5.67%, AB Overlap: 10.48%, AC Overlap: 2.05%, BC Overlap: 1.36%. Data from SILC and HBS 2023, Czech Republic.

Expenditure-Based Energy Poverty Indicators

- **2M Indicator:**
  - Households are energy poor if they spend **more than twice the national median share of income** on energy.
  - Captures relative differences across income groups.
- **10% Rule:**
  - Households are energy poor if energy expenditure exceeds **10% of total income**.
  - Simple and intuitive but criticized for being arbitrary.
- **Low Income, High Costs (LIHC):**
  - Households with **below-average incomes** and **above-average energy costs** are considered energy poor.
  - More robust than the 10% rule; used in UK policy.

Definition of Key Variables

Income (Y_i): Net disposable household income from all sources (employment, self-employment, social benefits, etc.)

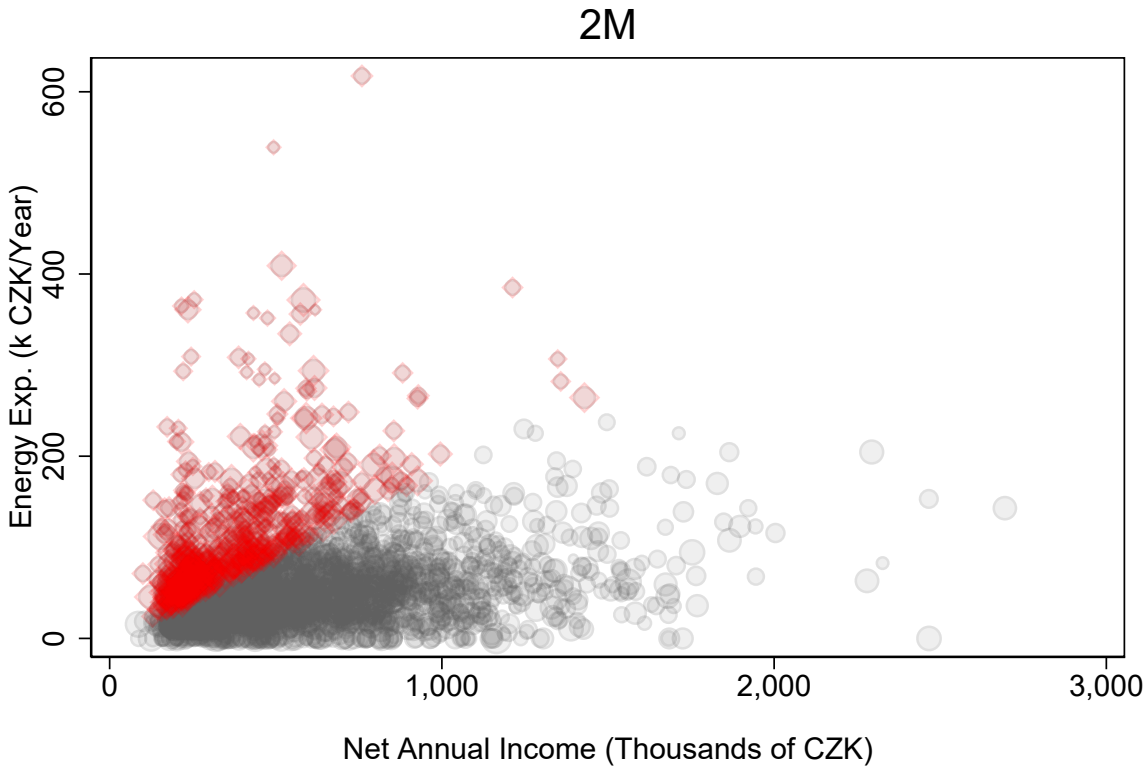
Energy (E_i): Total household expenditure on electricity, gas, solid fuels, and other energy carriers for heating, cooling, and appliances

Housing (H_i): Rent or mortgage payments, maintenance costs, and other housing-related expenses excluding energy costs

Poverty Line (PL): 60% of the median net household income

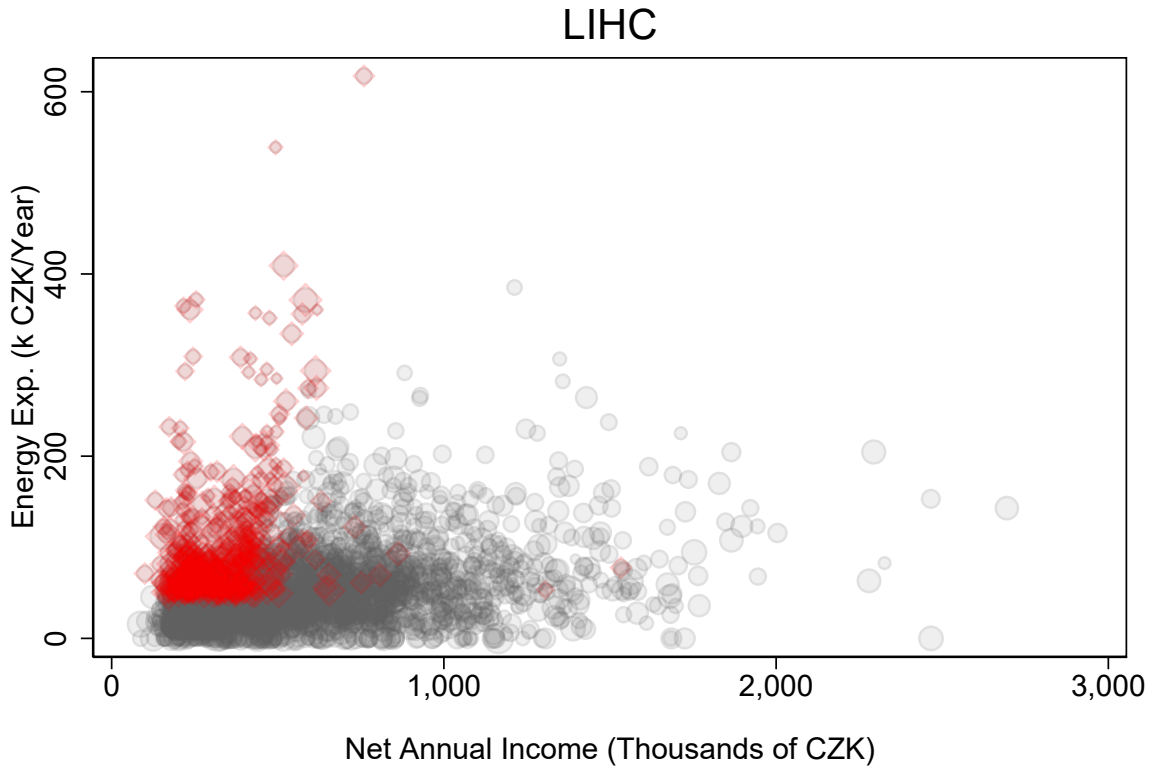
2M Indicator - CZ 2023

$$2M_i = \begin{cases} 1 & \text{if } \frac{E_i}{Y_i} > 2 \times \text{Median}\left(\frac{E}{Y}\right) \\ 0 & \text{otherwise} \end{cases}$$



LIHC Indicator - CZ 2023

$$\text{LIHC}_i = \begin{cases} 1 & \text{if } (Y_i - H_i - E_i) < \text{PL and } E_i > \text{Median}(E) \\ 0 & \text{otherwise} \end{cases}$$



2MLIHC: Theoretical Foundation

Motivation:

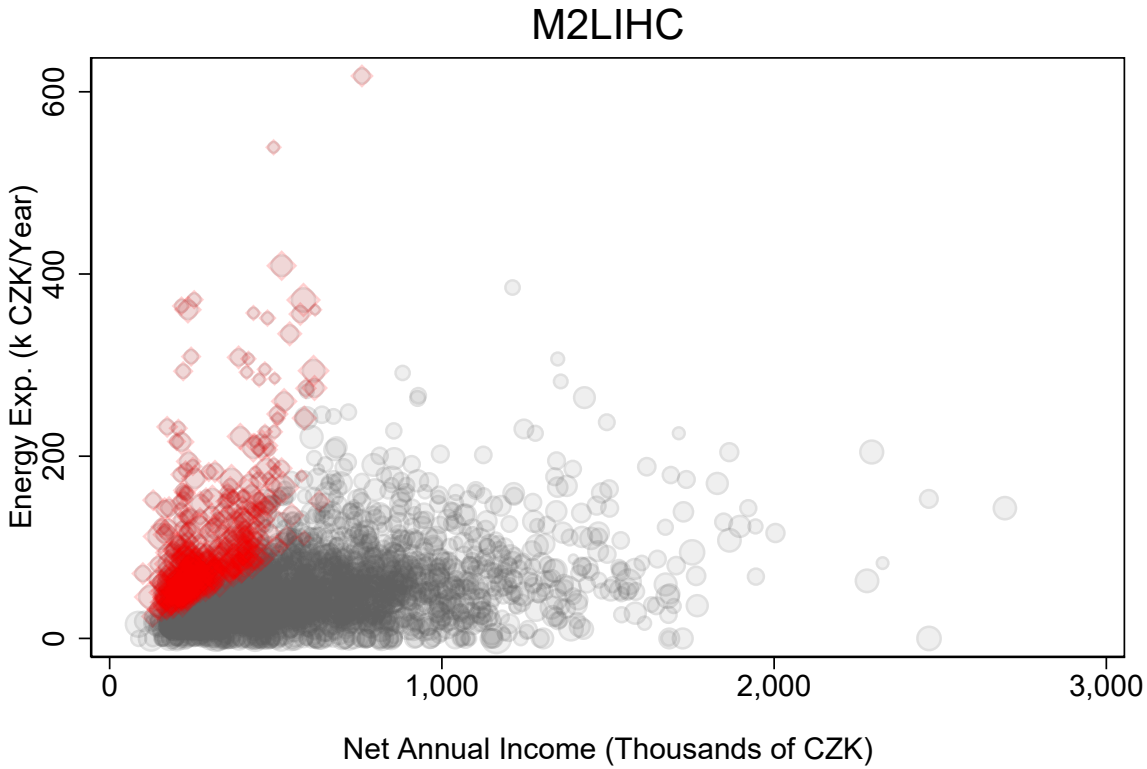
- 2M: Captures relative energy budget share
- LIHC: Accounts for absolute poverty
- 2MLIHC: Combines advantages while mitigating limitations

Key Properties:

- Maintains income sensitivity
- Avoids wealthy household misclassification

2MLIHC Indicator

$$\text{2MLIHC}_i = \begin{cases} 1 & \text{if } (Y_i - H_i - E_i) < \text{PL and } \frac{E_i}{Y_i} > 2 \times \text{Median}\left(\frac{E}{Y}\right) \\ 0 & \text{otherwise} \end{cases}$$



Data Sources

Two primary sources:

- Household Budget Survey (HBS):
  - Detailed expenditure patterns
  - 3,365 households (2023)
- SILC:
  - Income and living conditions
  - 11,000+ households

Dataset Construction

- Merged HBS-SILC dataset:
  - Coverage: 2017-2023
  - Representative sample
  - 4.55 million households (2023)
- Key variables:
  - Income components
  - Energy expenditures
  - Housing costs
  - Household characteristics

Trends 2017-2023 – Ex post

Year	2M%	LIHC%	2MLIHC%	Mean(Y)	Mean(E)	N	Popul.(k)
2017	10.8	12.1	15.3	372	36	841	1369
2018	13.5	13.0	15.4	414	37	1848	3105
2019	15.8	12.7	15.0	439	34	2897	3600
2020	16.6	13.0	14.0	426	31	3660	4461
2021	18.2	13.9	14.5	454	31	3487	4488
2022	18.9	14.4	14.2	499	34	3423	4487
2023	17.3	15.1	16.1	532	47	3365	4546

Table: Energy Poverty Indicators and Statistics (Income & Energy in thousands CZK)

Income Decile Analysis – Ex post

Decile	2M	2MLIHC	LIHC
1	44.47	44.04	36.15
2	31.89	29.93	29.73
3	24.84	21.28	29.10
4	20.74	15.87	21.83
5	18.28	10.10	15.85
6	13.75	6.49	12.09
7	10.53	5.33	7.35
8	7.86	2.77	4.11
9	5.04	1.63	2.05
10	1.91	0.10	0.81
Total	17.29	13.25	15.13

Table: Energy Poverty Indicators by Income Decile (%)

DASMOD Model: Overview – Ex Ante

Static microsimulation approach:

$$q_k^1 = q_k^0(1+\Delta P_k)^{(1+\eta_{kk})} \times \prod_{c \neq k}(1+\Delta P_c)^{\eta_{kc}} \times (1+\Delta Y)^{\eta_k^y}$$

where:

- q_k^0, q_k^1: quantities before/after policy change
- ΔP_k: price change
- η_{kk}: own-price elasticity
- η_{kc}: cross-price elasticity
- η_k^y: income elasticity

Key Features:

- Models household responses to price changes
- Incorporates multiple elasticities
- Enables detailed policy analysis
- Uses household-level microdata
- Simulates distributional effects

E3ME Integration and WAM Scenario

- **E3ME Integration:**
  - Macro-econometric model covering global economy
  - 49 regions including each EU Member State, hence also CZ
  - Provides price and income change predictions for DASMOD
  - Focus on 2027,2030 and 2032 impacts
- **WAM Scenario Targets:**
  - Introducing ETS2 from 2027 with EUAs and fossil fuel prices as in High Carbon Transition (EC 2024)
  - 63% emission reduction (endogenous) vs 1990 by 2030
  - 68% reduction in ETS sectors vs 2005
  - 32% reduction in non-ETS sectors
  - Coal phase-out by 2033
  - 30% renewable energy by 2030
  - WAM is the main scenario chosen by the CZ for the updated NECP-CZ in 2024

NECP CZ WAM Compensation Scenarios

Compensation Scenarios (Deciles 1 & 2 only):

- **WAM0:** No compensation
- **WAM316:** EUR 316/year (CZK 7,734)
- **WAM408:** EUR 408/year (CZK 10,000)
- **WAM816:** EUR 816/year (CZK 20,000)
- **WAM1246:** EUR 1,246/year (CZK 30,522)

Key Features:

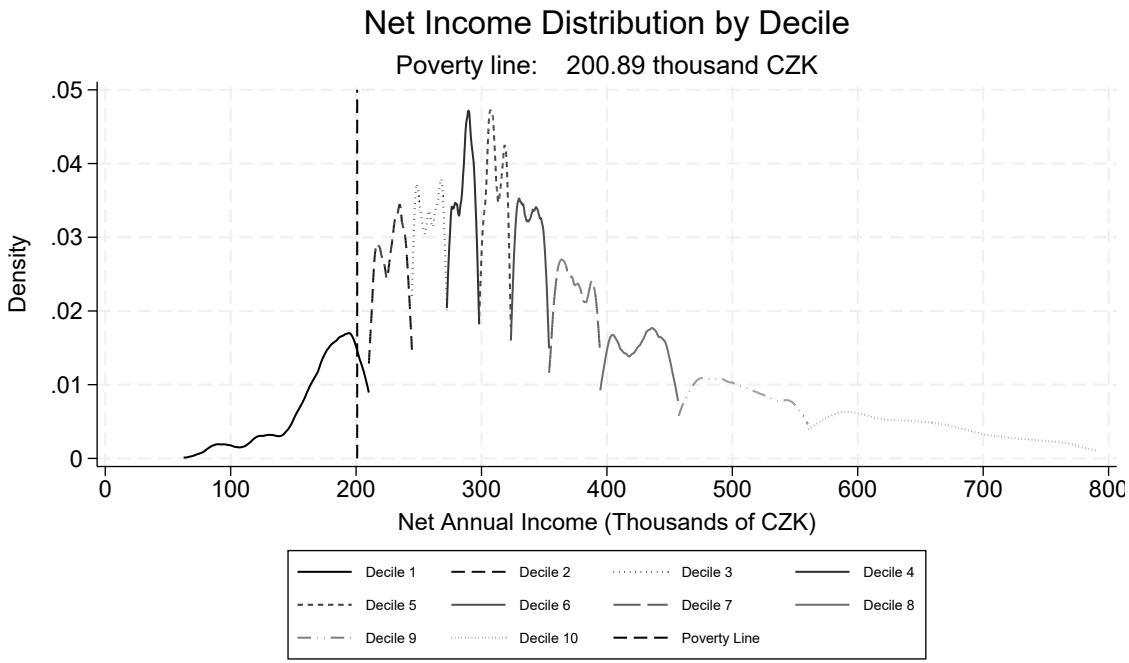
- Revenues from sold EUAs and their allocation to Modernisation and SCF are endogenously determined by the E3ME model
- A part of the revenues allocated to CZ are used for lump-sum social compensations
- Targeted support for lowest income households requested by Gov
- Range of compensation levels
- Designed to mitigate energy poverty?

WAM Scenarios: Impact on Energy Poverty Indicators

Scenario	2M	LIHC	2MLIHC
WAM0 (no comp.)	21.75%	14.39%	14.63%
WAM7734	21.70%	14.46%	14.53%
WAM10k	21.65%	14.48%	14.48%
WAM20k	21.64%	14.60%	14.44%
WAM30522	21.56%	14.69%	14.28%

Table: Total population values across compensation scenarios for year 2027

The LIHC Energy Poverty Paradox



Why is it a paradox?

When income increases by 10% for a HH:

- Energy spending increases by x% (depends on elasticity 0.8-1.21)
- This higher spending can push households above the median energy cost threshold
- Result: Some households become "energy poor" despite having more income

Similarly, when income decreases:

- Energy spending falls even more
- Households may fall below the threshold
- Result: They are no longer counted as "energy poor" despite being poorer

2MLIHC Response to Income Changes

- Shows expected policy responses – evaluated by the micro-simulation model DASMOD
- **Importantly**, the main point of this exercise is not to find the "expected policy response" indicator, but to show the reaction of various indicators on policy action

Key Findings from WAM Scenarios

- **Statistical Significance:** Changes in energy poverty rates across compensation scenarios fall within confidence intervals (range within almost 1.5 pp), suggesting compensation does not significantly reduce energy poverty
- **Counter-intuitive LIHC:** Higher compensation leads to slightly increased LIHC values (14.39% $\rightarrow$ 14.69%), demonstrating the paradoxical nature of this indicator
- **2MLIHC Stability:** Shows most consistent behavior, with slight decrease as compensation increases (14.63% $\rightarrow$ 14.28%), avoiding LIHC's counter-intuitive properties while maintaining reasonable sensitivity

Methodological Constraints and Critical Assessment

Data and Model Limitations

- Static Nature of Analysis
  - Misses dynamic household adaptations
  - Cannot capture long-term behavioral changes
  - No effect on intensive or extensive margin in labour supply
- Limited Housing Quality Data
  - No energy performance certificates
  - Missing renovation history
- Elasticity Assumptions:
  - Uniform across income groups
  - Short-term vs. long-term adjustment paths
- Modeling Transport poverty:
  - Transportation poverty not included, but we plan to add it through per adult transportation expenditures.
  - Social compensation may affect both transport and energy poverty – we plan to analyze these interlinkages

Key Conclusions and Policy Implications

- Direct income support has limited effectiveness
  - Compensation (EUR 316-1,246) reduces 2MLIHC by only 0.35pp (not statistically significant)
- Need for comprehensive policy approach
  - Policy makers should know how indicators behave
  - Combine energy efficiency measures for long term solution since short time compensation may lead to wasting money
  - Consider regional and socio-economic variations
- Indicator choice matters for policy evaluation
  - Different indicators may suggest conflicting policy outcomes
  - 2MLIHC provides more reliable policy assessment tool

Future Directions

Research Extensions

- Dynamic analysis development
- Include job market reaction
- Long-term effectiveness studies

Thanks for your attention!

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